Office of the Chief Scientist for Human Factors

Human Factors Aviation Maintenance

Program Review
FY02

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The Federal Aviation Administration Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) directs an aviation maintenance human factors program that focuses on identifying human factors issues across all aspects of aircraft maintenance and inspection personnel. The Aviation Maintenance research program has maintained a focused research approach in four major components – skill development, organizational influences, human error, and maintainer proficiency.

The following report lists projects between October 1st, 2001 and December 31st, 2002 (Appendix I). These projects address requirements identified by the Federal Aviation Administration Flight Standards office (Appendix II). The intent of this report is to allow Federal Aviation Administration sponsors to determine whether their requirements have been satisfactorily addressed, allow investigators to receive feedback from Federal Aviation Administration sponsors and other interested parties, and to provide feedback to the AAR-100 aviation maintenance program manager on the quality of the research program. Basically, this document is a means of holding each group (sponsor, investigator, AAR-100 program manager) accountable to ensure that the program is successful.

In FY02, the aviation maintenance research program distributed $934,500 contract and grant dollars to multiple organizations. In addition, one project received supplemental support from the Civil Aerospace Medical Institute, Oklahoma City, OK. These FY02 projects are described in Appendix I and the requirements that are mapped to these projects are located in Appendix II.

Three FY02 annual reports were not submitted due to the late execution of funds to the researchers. These three projects “An Evaluation of Broadband Applications to Aircraft Maintenance Safety”, “Language Barriers Result in Maintenance Deficiencies”, and “Using Technology to Support Inspector Training” reports will be submitted in the FY03 program review.

Appendix III lists the FY03 proposed projects ($850,000 contract dollars) and the proposed FY04 ($850,000 contract dollars) and FY05 projects ($700,000 contract dollars).

Address questions or comments to:

William K. Krebs, Ph.D.

Appendix I

Human Factors Aviation Maintenance

FY02 Funded Projects

Primary investigators submitted project summaries via world-wide-web. A newly created interactive web-based system modeled after the Office of Naval Research and the National Science Foundation was developed to standardize the yearly report submitted to the Office of the Chief Scientist for Human Factors. The reporting system can be found at http://www.hf.faa.gov/report

Project Title: *Task-Based Vision Requirements for Aircraft Inspection Personnel*

Primary Investigator: Bettina L. Beard, NASA Ames Research Center, Moffett Field, CA, (email tlbeard@mail.arc.nasa.gov)

Co-Primary Investigator: Willa Hisle, Albert J. Ahumada, Jr.

FAA Sponsor Organization AFS-300 (POC: Rusty Jones)

Sponsor's Requirement Statement: to determine the proper standards to be employed in the visual acuity testing of persons inspecting aircraft and aircraft components. **Refer to page 67 for a more detailed description.**

Research Project's Goal The main FY03 goal is to systematically evaluate performance with vision loss using a paradigm that permits performance measurements in the same well-trained maintenance inspectors or novice observers across tasks and visual deficits. The amount of control using this paradigm is greater than using individuals with visual anomalies because what was done to the signal is exactly known. The central question that must be addressed is "At what level of visual deficit would a maintenance or inspection worker become unable to perform the critical visual tasks required by the job in a safe and efficient manner?" To respond to this question, several preliminary issues must be considered including a determination of the critical vision tasks that the workers are required to perform. For inspection, this critical task analysis will be provided by the Civil Aerospace Medical Institute (CAMI). NASA will then write computer code to simulate various pre-defined vision deficits such as color weakness, mid-spatial frequency contrast sensitivity loss, cataract, etc. The actual list of visual deficits will be determined from the list of vision-dependent tasks defined by CAMI. This software will then be integrated into a well controlled, validated psychophysical paradigm such as that currently used in medicine to investigate tumor detection by physicians

Best Accomplishment : Our major review of the occupational vision standards literature can be used by any occupation interested in writing or updating a vision standard. Other occupational managers who have shown an interest in the results of this review include U.S. Bridge Inspectors, the Coast Guard, the Trucking Industry, and Welders.

Project Summary: Currently no general standard exists in the aviation industry for the visual qualifications of inspectors; however, the various aircraft maintenance facilities have developed their own, unique vision qualification programs. This highlights the need for a uniform and universally accepted set of vision standards that would apply to all aircraft NDI/NDT personnel. In FY02, we compiled a text and WEB-based search for occupational vision requirements, knowledge gained from site visits to major aircraft maintenance facilities, relevant information from technical, mechanical, and inspection textbooks, the FAA maintenance human factors web-site and the human vision literature. A principal intent of this

literature review was to gather current knowledge about aircraft inspection and human vision, combined with current vision standards required for various other occupations, in preparation for establishing vision standards for specific NDI and visual inspection tasks

Scientific and Technical Objectives: FAA Requirement states that the Project, at a minimum, will determine standards for near visual acuity, distance visual acuity, and color perception for aircraft maintenance inspectors. In a 2001 FAA Advisory Circular (AC No: 65-31), recommendations are made for examination guidelines for the vision of NDI personnel. It is stated that near vision in one eye, corrected or uncorrected, must be at least 20/20. At a minimum this portion of the vision examination must be repeated yearly. Color vision guidelines state that an inspector must be able to: "distinguish and differentiate between colors necessary for the inspection method for which evidence of qualification is sought."

The 2001 AC previously mentioned was specifically written to address the vision standards for radiographic, magnetic particle, ultrasonic, liquid penetrant, and eddy current imaging techniques. In conjunction with the FAA, NASA proposes to expand these recommendations to include the two most common inspection techniques, visual and borescope inspections.

Technical Approach: This report was divided into four main sections. The first section described the FAA requirement calling for vision standards for NDI/NDT inspectors. We then discussed NDI/NDT basic training, tasks and visual needs and provided an overview of field observations taken by the authors of this report. Section 2.0 excerpted the visual perception literature as it pertains to setting visual requirements. It was shown that the tools to predict real-world performance are just now reaching maturity. This section also outlined current vision standards for some vision-intensive occupations and whether these standards were empirically derived, based on expert opinion, or borrowed from other occupations. We then discussed to what extent these standards could be applied to aviation maintenance inspection. In Section 3.0 recommendations were provided for vision standards that specifically relate to the vision needs of NDI/NDT inspectors.

Results: Our review revealed no studies which allow generalization of findings – the occupational tasks are too dissimilar. The standards for aircraft maintenance inspectors should reflect a more sensitive, evidence-based approach than to just use the existing literature based on other occupational needs. Any vision standard to be developed for aviation maintenance inspectors must take into account their specialized inspection tasks and the environments in which they work.

Impact/Applications: In our literature review we concluded that current vision standards written for other occupations cannot be directly adopted when writing aircraft inspection vision standards since the tasks performed by different

occupations differ substantially from aviation maintenance inspection tasks. Additionally, the majority of occupational vision standards are not empirically substantiated, and appear to be arbitrarily decided. The implication of this finding is that the FAA must sponsor further research to develop meaningful vision standards for aircraft maintenance inspection.

Technology Transfer: NASA is working closely with CAMI in the development of these vision standards. In FY03, CAMI will provide NASA with a list of critical occupational tasks and the specific visual functions associated with these tasks. NASA will then provide CAMI with empirical results which relate performance on these tasks with specified visual deficits. CAMI will use these results to define the vision standards for aircraft maintenance inspection.

Journal Articles: none

Books or Chapters: none

Technical Reports: Beard, B.L., Hisle, W.A., Xing, J., and Ahumada, A.J. (2002, 15 October). *Behind The Setting Of Vision Standards For Aircraft Maintenance Inspection*, NASA Ames, unpublished report.

Conference presentations/abstracts: Beard, B.L. (2003) A Methodology for Defining Occupational Vision Standards. Annual Interdisciplinary Conference in Teton Village, Jackson Hole, Wyoming, February 2-7, 2003

Patents Issued or Pending: none

Honors: none

Related Projects: none

Project Title: Vision Standards and Testing Requirements for Nondestructive Inspection (NDI) and Testing (NDT) Personnel and Visual Inspectors

Primary Investigator: Gregory W. Good, O.D., Ph.D., The Ohio State University, College of Optometry, Columbus, Ohio, (email good.3@osu.edu)

Co-Primary Investigator: Van B. Nakagawara, O.D. Vision Research Team Coordinator, AAM-630

FAA Sponsor Organization AFS-300 (POC: Rusty Jones)

Sponsor's Requirement Statement: to determine the proper standards to be employed in the visual acuity testing of persons inspecting aircraft and aircraft components. **Refer to page 67 for a more detailed description.**

Research Project's Goal : The desired goal of this project will be the development of an appropriate vision standard by which vision testing can be performed and documented for personnel responsible for inspecting aircraft and aircraft components. An acceptable vision standard will assess the initial job applicant and reevaluate current employees at appropriate intervals to determine whether their level of visual performance is consistent with the job-related visual demands placed on NDI/NDT personnel.

Should it be deemed necessary, additional study using this methodology may be conducted to establish the minimum vision requirement for other aviation related activities.

Best Accomplishment : Three specific questions were addressed by a comprehensive literature search with the following results.

- Detailed job-task analyses have documented the many varied tasks performed by these aircraft maintenance technicians (AMTs); however, these studies failed to document the specific visual tasks performed by NDI/NDT and Visual Inspectors.
- Demographic statistics specific to NDI/NDT and visual inspection personnel have not been reported in the literature. However, for general AMT personnel, studies report a mean age of 36.2 years, a bimodal AMT experience distribution (peaks at 9 and 31 years), and an under-representation of women and minorities.
- There are no reports in the literature that discuss the refractive needs, corrective modalities, or overall visual health of NDI/NDT personnel in the aviation industry.

The lack of vision-specific data and an accurate demographic description of the NDI/NDT and visual inspector workforce will require the execution of Phase II to meet the objectives of this project.

Project Summary: The goal of this project is to determine the proper standards to be employed for vision testing persons responsible for inspecting aircraft and aircraft components using non-destructive inspection and testing (NDI/NDT) procedures. Recommendations will then be set forth in an Advisory Circular or eventually be included as an amendment to the Federal Aviation Regulations. This project would involve, as a minimum, the following:

a) Establish the standard to be used for both near and far vision tests.
b) Establish the standard to be used for testing color perception.
c) Determine who will be required to meet these minimum standards for performance of their job function.
d) Determine the time interval when vision tests will be administered.
e) Establish written procedures to provide guidance to organizations that will need to setup programs for administering and documenting the visual acuity examinations.
f) Determine if these standards should be included in an Advisory Circular or as an amendment to the Federal Aviation Regulations.

The project was divided into two phases with various tasks assigned to the NASA Ames research group and the Civil Aerospace Medical Institute/Ohio State University (CAMI/OSU) research group. Due to the number of NDI/NDT procedures and limitations on time and resources, it was decided that the project would initial concentrate on three procedures identified in studies performed by Dr. Colin Drury (i.e., Borescope, Fluorescent Penetrant and Visual Inspections). Research activities in Phase I would determine if the information necessary to accomplish the objectives mentioned above already existed. Phase II would be initiated only if the information collected in Phase I was found to be insufficient to accomplish all the objectives of this project. Phase I activity required CAMI/OSU researcher personnel to answer the following questions:

a) Have NDI/NDT and visual inspection human factors visual task analyses been conducted?
b) Are there demographic statistics for NDI/NDT and visual inspection personnel?
c) Are there optometric data on NDI/NDT and visual inspection personnel?

To address these questions a comprehensive literature search was conducted that included the review of all relevant text-based material and computer searches of several on-line databases. The database in which the most pertinent papers were found was that for the Human Factors in Aviation Maintenance and Inspection (hfskyway.faa.gov). Within the listing for *Aviation Maintenance and Inspection Research Phase Reports* from 1988 to 2002, “maintenance, visual,

and inspection" were used as keywords for this search. One hundred fifty-six references were obtained from this database. Other databases searched were MEDLINE (Index to journal literature in health sciences) and COMPENDEX (Index to journal literature in engineering science). All documents considered relevant to the visual demands of NDI/NDT inspection procedures, NDI/NDT population demographics, and their optometric condition were obtained and reviewed

Scientific and Technical Objectives: Conduct a literature review.

Technical Approach: to determine if sufficient information is currently available to describe the visual demands placed upon NDI/NDT and visual inspection personnel in order to determine the appropriateness of the presently recognized vision standard. This was accomplished by a comprehensive literature search and review of all available documents relevant to NDI/NDT operations. In addition, tours of representative facilities (2 sites) were conducted to familiarize the investigators with the general scope of job tasks and responsibilities that are demanded of NDI/NDT personnel and visual inspectors. The intent was to document the following:

a) The demographic profile of NDI/NDT positions;
b) A detailed description of the essential tasks and visual processes required (i.e., visual job task analysis); and
c) The description of optometric characteristics of NDI/NDT personnel.

Because this information was not present in the literature with sufficient detail, a decision was made to proceed with the execution of Phase II.

Results: There were no reports in the literature that discussed the refractive needs, corrective modalities, or overall visual health of NDI/NDT personnel in the aviation industry.

Impact/Applications: The Federal Aviation Regulations (CFR, Part 67) provides requirements for visual acuity testing for first, second, and third class airman medical certificates to ensure that aviators possess the visual skills required to perform the operational duties of their particular class. Various programs for the certification of persons performing nondestructive inspection and testing require vision examinations prior to certification. These requirements are neither uniform nor standard throughout the industry, nor do they appear to be based on the visual demands required of these workers. There currently is no vision standard for a person performing visual inspections to be tested for visual acuity or color perception. The project described in this report should provide the data necessary to develop a job-related vision standard for NDI/NDT and visual inspection personnel similar to CFR Part 67 used for pilot certification. Implementation of such a standard should enhance flight safety by assuring that personnel conducting NDI/NDT procedures possess the appropriate level of visual performance to effectively perform their duties.

Technology Transfer: none

Journal Articles: none

Books or Chapters: none

Technical Reports: Good, G.W. and Nakagawara, V.B. (2002, 15 October). *Vision Standards And Testing Requirements For Nondestructive Inspection (NDI) And Testing (NDT) Personnel And Visual Inspectors*, Ohio State University unpublished report.

Conference presentations/abstracts: none

Patents Issued or Pending: none

Honors: none

Related Projects: none

Project Title*:* *Review Amateur-Built Aircraft Accident/Incidents*

Primary Investigator: Nicole Nelson, Civil Aerospace Medical Institute, Oklahoma City, Oklahoma (email: nicole.nelson@faa.gov)

Co-Primary Investigator: Edna Fiedler & Scott Goldman at Civil Aerospace Medical Institute, Oklahoma City, Oklahoma

FAA Sponsor Organization: AFS-300, (POC: William O'Brien)

Sponsor's Requirement Statement: To determine the causal factors (e.g., human factors, construction, operation, maintenance and other factors that cause accidents) surrounding the high accident and incident rate for amateur-built aircraft per 100,000 hours of operation. **Refer to page 60 for a more detailed description.**

Research Project's Goal: General aviation flight hours continue to increase: A-B aircraft flight hours, alone, increased from under 300,000 hours in 1993 to about 900,000 in 2000. The new sport pilot regulations (NPRM FAA Docket –20001-11133 Notice No 02-03) are likely to stimulate an additional increase in A-B flight hours. If an increase of A-B flight hours occurs, a corresponding increase in maintenance related accidents would also be expected. A taxonomy of the most frequently occurring maintenance errors can be used as the basis for future interventions. Subsequent research could determine the efficiency of the interventions in reducing the prevalence of accidents and fatalities.

Best Accomplishment: During a September meeting the sponsor asked AAM-520 to prepare a synopsis comparing A-B to all other general aviation G-A for an October meeting. Although this comparison was originally due December 2002, AAM-520 agreed this time to prepare the requested summary two months in advance to help the sponsor.

Project Summary: Although maintenance-related accidents and incidents remain steady over the past decade, there has been little work on the causes of these mishaps. In a previous study, Goldman, Fiedler, and King (2002) found that a little over 7% of the 1983-1999 National Transportation Safety Board general aviation (GA) investigation reports listed at least one maintenance-related error as the primary cause or factor. They also found that installation was the most frequently cited maintenance activity associated with GA maintenance-related accidents.

Reducing maintenance and pilot errors is crucial to general aviation safety, and A-B aircraft are no exception to this assumption. A-B aircraft, by definition are homebuilt, and design modifications, construction, and maintenance procedures are often carried out by one individual, who may or may not have much background in aviation construction or maintenance. The same person who built the aircraft often flies the aircraft. Again this person may have had little flying experience with the specific homebuilt aircraft.

In the last decade, there has been a significant increase in the number of homebuilt aircraft and the number of hours flown. The APO General Aviation and Air Taxi Activity Survey of 2000 reported that between 1993 and 2000, active A-B aircraft had risen from a little under 6000 to over 16,000 aircraft. The same survey also reported that from 1993 to 2000, hours flown went from under 300 thousand to about 900 thousand hours.

However, the accident rate of homebuilt compared to general aviation far surpasses the proportion of homebuilt aircraft in the general aviation community. The 1997 NTSB Annual Review of Aircraft Accident Data for US GA reported that A-B aircraft accounted for 3% of the aircraft hours flown in GA flying, but made up 10% of the accidents. The same review also reported that A-B aircraft involved in accidents were destroyed 50% more often than were manufactured aircraft and the pilots were killed twice as often.

In a preliminary study, CAMI researchers found that the rate of maintenance-related accidents for A-B aircraft were similar to that of rotorcraft, a type of aircraft well known for its high maintenance requirements. From 1988-1997, CAMI found there were 59 fatalities and 120 injuries in 211 maintenance-related homebuilt accidents.

Using the 1983-2001 National Transportation Safety Board GA accident investigation reports, this study compares maintenance-related accidents for A-B, rotorcraft, and all other GA aircraft by type of maintenance procedure, airframe hours, phase of operation, and time since last inspection. For this 18-year sample of maintenance-related accidents, 413 involved A-B aircraft, and 3262 involved all other types of GA aircraft. Maintenance procedures and maintenance personnel are defined by the codes used by the National Transportation Safety Board. All analyses include overall accident rate, fatalities, and injuries.

Analyses were completed to provide a human factors taxonomy of maintenance-related causal factors for A-B aircraft. Subsequently, this taxonomy was analyzed in more detail to determine the frequency of fatalities and injuries by causal factors. This taxonomy of maintenance-related causal factors for A-B aircraft was then compared to causal factors for all other GA maintenance-related accidents. All analyses completed for A-B aircraft (fatalities, injuries, airframe time, phase of operation, and time since last inspection) were also completed for all other maintenance-related GA accidents. This research provides policy makers with information that can be used to guide GA accident prevention and in the development of advisory circulars.

Scientific and Technical Objectives: The objective was to use quantitative data to identify patterns of maintenance related causal factors in A-B and all other GA aircraft. This information will be used to generate maintenance related safety recommendations.

Technical Approach: Investigators developed a database through 2001 of all relevant GA A-B aircraft accidents. Analyses were completed to provide a human factors taxonomy of maintenance-related causal factors. Subsequently, this taxonomy was analyzed in more detail to determine the rate of fatalities and injuries by causal factors. Other factors studied in relation to fatalities and injuries were airframe time, phase of operation, and time since last inspection.

This taxonomy of maintenance-related causal factors for A-B aircraft was then compared to causal factors for all other GA maintenance-related accidents. All analyses completed for A-B aircraft (fatalities, injuries, airframe time, phase of operation, and time since last inspection) were also completed for all other maintenance-related GA accidents.

Results for A-B and all other GA maintenance-related causal factors were integrated in a briefing report for AFS-300.

Results: Accidents and Fatalities
From 1983 to 2001, A-B aircraft had 3572 accidents, with 1082 fatalities or 30%. All other GA aircraft had 34,482 accidents, with 6582 fatalities or 19%.

Maintenance–Related Accidents and Fatalities
Of the 3572 A-B accidents, 395 or 11% were M-R accidents. Of the 34482 all other GA accidents, 2327 or 7% were M-R accidents. There were 151 fatalities in the 395 M-R accidents for A-B, or 14% of the 1082 fatalities for A-B. There were 810 fatalities in the 2327 M-R accidents for all other GA, or 12% of the 6582 fatalities.

Installation was identified as the leading cause for M-R accidents in A-B, responsible for 127 or 32% of the M-R accidents in A-B. Installation was identified as the leading cause for M-R accidents for all other GA, responsible for 397 or 17% of the M-R accidents in all other GA.

For those 104 A-B investigations that both listed M-R as a causal factor and reported airframe time, there were 19 fatalities (18%) in the first hour of flight. For those 682 all other GA investigations that both listed M-R as a causal factor and reported airframe time, there were 20 fatalities (.03%) in the first hour of flight. Thus, when maintenance is a causal factor, A-B accidents are approximately six times more likely to result in a fatal outcome in comparison with accidents in all other GA.

For the two samples which included only those investigations in which M-R was a causal factor and the airframe time was reported, there was only 1 more fatality in the sample of all other GA than its equivalent sample in A-B. This small difference occurred despite the fact that there were over 6 times as many accidents in this restricted sample of all other GA during the first hour of flight.

Impact/Applications: Little research has been completed that investigates the causal factors of A-B accidents, and the research that has been done is several years old. To reduce the likelihood of future A-B accidents, the FAA, industry partners, and the GA community needs information on the causal factors of A-B accidents. The research report and documentation from this study will be given to AFS to use in their creation of an Advisory Circular or Safety related training on CD or video to be used by the FAA safety program

Technology Transfer: Taxonomic information garnered from this research can be used by industry in the creation of their aircraft construction manuals. This information may also be sent out directly to the homebuilt owners, as well as presented at conferences and workshops geared toward homebuilt owners (e.g., E.A.A.'s Air Adventure). A further application of this research is the creation of an interactive computer program, such as a maintenance teaching tool. Ideally, this program would allow the homebuilt owner to actually view 3-D representations of common maintenance mistakes (e.g., reversal of a part in the installation process) and also show the correct way to accomplish the procedure.

Journal Articles: none

Books or Chapters: none

Technical Reports: none

Conference presentations/abstracts: none

Patents Issued or Pending: none

Honors: none

Related Projects: none

Appendix II

Human Factors Aviation Maintenance Research Requirements

Research requirements exist in the AAR-100 interactive management database that allows program managers to track research requirements for each Federal Aviation Administration sponsor.

Requirement ID: 919

Sponsor Organization: AFS-300 POC: Les Vipond

Requirement Title: AMT Career Selection

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: to determine the motivational factors that would interest prospective aviation maintenance technicians to join the aviation maintenance field. In particular, what motivational factors correlate with general aviation, business aviation, small to medium FBO's, helicopter operations, and contract maintenance.

Background: Economics is the reason most often cited as the principal driver in an AMT career selection. Meaning, the majority of new AMTs seek employment with large and medium size Part 121 airline carriers, while others seek general aviation facilities.

Output: A research report to document findings.

Regulatory Link: Part 91, 65, 147, 43

Requirement ID: 889

Sponsor Organization: AFS-230 POC: Tom Longridge

Requirement Title: An Assessment of Barriers to Implementation of Aviation Safety Action Programs (ASAP) in Maintenance Organizations

Funded Requirement:

- FY02: No
- FY03: Yes
- FY04: Yes
- FY05: Yes

Requirement Statement: The goals of the project are as follows: 1) To determine the human factors issues involved in ASAP, 2) Identify barriers in implementation of ASAP, 3) Perform benchmarking studies of maintenance facilities that use ASAP to determine the best practices in the industry, and 4) To determine the best methods for reporting, documenting, and analyzing human factors issues surrounding maintenance errors identified via ASAP.

Background: As safety programs and tools sponsored by FAA continue to evolve, the maintenance community continues to struggle with their use and applicability. The Aviation Safety Action Program (ASAP) is one example of a program that was initially created for use by flight operations organizations within air carriers, then adapted for use by maintenance organizations. This adaptation has been less than successful, and has resulted in a low number of maintenance organizations using ASAP. This research initiative will address why current ASAP programs do not adequately support the management of maintenance error through exclusion of certain risks existent in the maintenance system, highlight the difficulty with comprehensive fixes, and validate the difficulties encountered when entering into "voluntary" programs with the regulator.

Output: Final report identifying why ASAP is often not implemented in the maintenance industry and a discussion of methods for overcoming these barriers. This report will also recommend possible solutions to aviation maintainers' concerns about ASAP that have already been expressed, e.g., voluntary disclosure and self-disclosure overlap. In addition, the report will compare and contrast ASAP programs to determine which practices work best and provide guidance to the best methodology for collecting and utilizing human factors ASAP data.

Regulatory Link: none

Requirement ID: 923

Sponsor Organization: ATA Maintenance Human Factors Subcom POC:

Requirement Title: An Assessment of Computer-Based Maintenance Resource Management (MRM) Training In Diverse Maintenance Environments

Funded Requirement:

- FY02: No
- FY03: TBD
- FY04: TBD
- FY05: TBD

Requirement Statement: to develop, test, and evaluate a scenario-based decision-making tool for use by the AMT workforce. Development and assessment of a scenario-based MRM tool should help the maintenance community get closer to the "LOFT" approach that has demonstrated success in flight operations decision-making environments.

Background: First generation MRM programs primarily measured training effectiveness via attitude surveys regarding how participants felt about the training they received. This study puts forth a proposal to study a (scenario-based) CBT MRM program that consists of multiple lessons, delivered as computer based instruction. Program content would consist of communication/decision-making skills, and elements known from previous research to influence a learners ability to understand and remember i.e., higher knowledge retention of desired safety-related behaviors. This requirement proposes a diverse approach, with participants consisting of: a university fixed-base-operator (FBO) AMT population, an FAA maintenance organization AMT population (AVN-200), and an FAR Part 121 air carrier AMT population. Program content would be the same for all populations, except that each population would have its' own unique scenarios.

For each population, all lessons would be contained on a single compact disk. Participants would receive disks and then take the training at times and places of their choosing. Limitations would be that participant's must use a PC with Windows 95 or later, must use the same computer for all three lessons, the computer must be equipped with a printer, and the participant's must complete the instruction within one week.

Integral to the assessment would be a computer administered pre-test and post-test to measure knowledge retention. The program would also measure and report six aspects of activity for each lesson, and would also ask for the participant's personal evaluation of the training. When a participant finished the training, the program would print a summary of the participant's learning, decision-making activity, and personal evaluation. Study administrators would

then consolidate the summaries to report, for each organization, how much the participant's actually learned, how much time the training actually required, and how the trainees appraised the value of their training.

Output: Development of a scenario-based MRM training program for AMT workforce.

Regulatory Link: none

Requirement ID: 864

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: An Evaluation of Broadband Applications to Aircraft Maintenance Safety

Funded Requirement:

- FY02: Yes
- FY03: Yes
- FY04: Yes
- FY05: No

Requirement Statement: To determine the extent to which human-centered design contributes to the successful application of emerging technologies that include, but are not limited to: training-on-demand, video-on demand, wireless access to technical documentation and much more. This research shall review the emerging technologies to the extent to which such technologies are impacting safety370

Background: Identification of emerging broadband applications to maintenance. Identification of safety impact of broadband technology. Assessment of positive and potential negative impact of broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology use in maintenance environments.

Output: Overview of the state-of-the-art of broadband applications to maintenance. Identification of safety impact broadband applications for maintenance technicians. An understanding of the integration between training and job-aiding as broadband technology using maintenance environments.

Regulatory Link: none

Requirement ID: 793

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Application of Human Factors Interventions to Improve Inspector Performance

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: There is no industry-wide standard or benchmark for inspector training. Task analysis of aircraft inspection and maintenance reveal that individual differences among inspectors is one of the leading factors that have the greatest impact on inspector performance263

Background: Evaluation and validation studies that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process

Output: An industry-wide benchmark for inspector training. Development of Prototype Inspection Aid

Regulatory Link: AVR Performance Plan (2000) NTSB Recommendation A-97-76/Report to Congress/FAA National Aging Aircraft Progam Plan/ Project Completion after 2001

Requirement ID: 802

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Assessment of FAR PART 145.159 Repair Stations - Training Requirements for maintenance production an

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: FAR PART 145 has been significantly revised. One of the major revisions is in the Training Requirements section. The NPRM for the 145 changes states: To provide time for repair stations to develop their training programs, this final rule provides that beginning 2 years after the effective date of the rule, each applicant for a repair station certificate, must submit a training program for approval by the FAA. It also states: A repair station certificated before that date [the effective date of the rule plus 2 years] must submit its training program for approval on the last day of the month in which its certificate was issued. Training requirements have evolved to ensure continuing safety in the international Repair Station maintenance work environment. This project shall provide the research and review to characterize the current state of training at Repair Stations and based upon evaluation and industry input, define a direction for the evolution of the necessary training requirements to ensure continuing safety. This information will be used by FAA to assist them in developing training requirements, guidance materials, and Aviation Safety Inspector Handbook information.1198

Background: Sponsor Need Description: A final report on the results of the evaluative research conducted on FAR PART 145 training requirements, that includes conclusions and recommendations on which the FAA may base guidance and Aviation Safety Inspector Handbook information. Desired Research Outcome: The outcome will be an objective report based upon research conducted with industry and FAA input. The desired outcome will be guidance materials that will assist industry in building practical, objective, training programs that meets both the needs of industry and the safety requirements of the FAA. The FAA will have substantive information on which to base guidance materials and ASI Handbook information.

Output:

Regulatory Link:

Requirement ID: 803

Sponsor Organization: AFS POC: les Vipond

Requirement Title: Assessment of Requirements for and Availability of Qualified Aviation Maintenance Technicians by 2005

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: To conduct an assessment of requirements for and availability of qualified aviation maintenance technicians for the year 2005. The Project Report will provide detailed information on findings, include conclusions based upon those findings, and will contain recommendations for the aviation industry and the FAA.312

Background: Sponsor Need Description: The year 2001 has swung a very unusual pendulum with respect to personnel requirements. At the outset of the year the entire aviation maintenance community was forecasting a severe shortage of AMTs (aviation maintenance technicians). A combination of terrorist attacks, along with a pending economic downturn, has resulted in significant reductions in the aviation maintenance workforce. In this cyclic trend of maintenance personnel current conditions suggest that there is no longer a shortage. The result is that more qualified technicians will likely permanently leave aviation for other career fields and that schools will also have lower enrollment, in fact additional schools may completely eliminate AMT training. When the industry inevitably returns to full strength, as in the past, the shortage occurs. The supply of qualified AMTs must be developed to meet the inevitable return and continued growth of the aviation transportation system. This study will review the current status, project personnel requirements and suggest means and methods to providing a supply of AMTs to meet forecast demand. GAO report. Desired Research Outcome: This study must position government, industry, and schools to fully understand the requirements for maintenance personnel and design training and certification programs accordingly.

Output:

Regulatory Link:

Requirement ID: 922

Sponsor Organization: AFS-300 POC: Les Vipond, John Goglia

Requirement Title: Auditing and Surveillance Maintenance Error Web-Based Tool

Funded Requirement:

- FY02: No
- FY03: Yes
- FY04: Yes
- FY05: No

Requirement Statement: develop existing PC /paper based auditing/surveillance tool to web-based application in performing auditing/surveillance/monitoring and validation of oversight of maintenance to ensure a consistent level of oversight is maintained. This system can proactively identify contributing factors of improper maintenance before aircraft is dispatched once work is complete. In addition, portions of this web-based surveillance/auditing tool can be used by aircraft manufacturers before delivery of aircraft to their customers.

Background: Several attempts have been made by FAA and industry to standardize error mitigation tools. Industry typically revises these tools to meet their own organizations' system, hence trending data across industry is difficult. Recently NTSB and a large manufacturer expressed interest in developing an existing PC and paper-based process used by large air cargo company to a web-based application. This web-based tool will help airlines, repair stations, air cargo, and manufacturers ensure compliance with FAA approved Continuous Airworthiness Maintenance Program. Development of this web-based application is to promote an environment of continuous improvement and team work by performing and documenting a variety of intentional and systematic surveillance oversight activities/inspections that make sure FAA regulations, airline, air cargo, and repair stations policies and procedures, and aircraft manufacture's maintenance procedures are complied with. This oversight is to insure that each aircraft dispatched is safe, airworthy, reliable and regulatory compliant. The web-based surveillance tool should incorporate findings from the following: a) In Process Surveillance, b)Verification Surveillance, c)Final Walk Around, d)Aircraft Walk Around, e) Quality Control, f)Inspection, g)Technical Data Control, h) Shelf Life Control, i) Tool/Test Equipment, j) Housing & Facilities, k) Safety/Security/Fire Protection, l) Storage, m) Work Processing, n) GMM Compliance, o) IPM Compliance, p) Fuel Surveillance, q) Description/Findings, r) Corrective Action/Follow up, s) Monitoring changes to and the accuracy of maintenance personnel, verifying that additions and recurrent training meet the requirements, and t) Airworthiness Directive Verification.

Output: De-identified web-based auditing/surveillance tool to be used by airline industry, air cargo, repair stations, manufacturers, and FAA. Results of surveillance and monitoring will correct or improve performance deficiencies. Findings can be shared by manufacturers, airlines, repair stations and air cargo's to help identify and prioritize factors that transcend across industry to foster elimination of these types of errors that are contributors /precursors and could systematically eliminate or reduce potential errors. Development of web-based system will meet Certification Process Study Finding 1 and Certification Process Implementation (CPI) Plan. Development of web-based system should be completed by December 2003 to meet goals of Certification Process Implementation (CPI) Action Plan. In addition, results of surveillance could be used to proactively disseminate lessons learned to industry and enable air carriers, manufacturers, air cargo and repair stations to identify potential errors when performing maintenance.

Regulatory Link: Certification Process Study and Certification Process Implementation Plan; NTSB recommendation

Requirement ID: 800

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Demonstration Project for AMT Training Delivered Using Distance Learning Technology: FAR 147 Certification

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Over the past 4 years the Aviation Maintenance Technician certification process, training requirements and delivery methods have been researched to develop better methods and processes. This research includes the development of new FAR 147 training requirements, a Structured Experience certification process, and the study of new methods for the delivery of AMT training utilizing distance education. A consistent outcome of this research is that it is very difficult to move from the status quo. If AMT training is to advance and utilize these new regulatory possibilities it will require a proven demonstration model for training providers to emulate. Additionally, using delivery methods that cross FAA regional and FSDO boundaries will require a single, uniform, tested process for training curriculum approval and the monitoring of student outcomes and instructional quality. This research initiative will address these issues and develop the pilot models that can serve as an example for both training providers and the FAA.1031

Background: Desired Outcome: Data or documentation required to support development of advisory circulars, rulemaking efforts, and changes or improvements to operations, maintenance or training procedures. The outcome of this project will be to provide the FAA and AMT training providers with a proven model for the delivery of training programs using distance learning technology for FAR 147 training, Structured Experience Certification training and AMT/IA recurrent training. This project will provide the data and documentation for advisory circulars, rulemaking, and FAA Airworthiness Inspectors Handbook. Sponsor Need Description: AFS-300 FAR 147 Rulemaking, FAR 65 (AMT experience requirement) Rulemaking, Enhanced AMT training and safety, NTSB recommendation A-89-56, AVR Performance Plan, and FAA Safer Skies Agenda.

Output:

Regulatory Link:

Requirement ID: 805

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Development of Best Practices for Confined Space Work

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: In order for the FAA to provide the public with continuing safe, reliable air transportation system it is important to have a sound aircraft inspection and maintenance system. The inspection/maintenance system is a complex one with many interrelated human and machine components. Recognizing this, the FAA has pursued human factors research. In the maintenance arena this research has focused on the aircraft inspector and the aircraft maintenance technician (AMT). Since it is difficult to eliminate errors altogether, continuing emphasis must be placed on developing interventions to make the inspection/maintenance system more reliable and/or more error tolerant. Recent NTSB reports, accidents have indicated that confined space work has the potential to cause increased damage to critical components/inferior inspection work/poor maintenance repair (e.g., wiring damage), increased risk to human health, or all the above. If we are to ensure that confined space work is performed effectively, efficiently and reliably over time, it is critical that we identify appropriate human-factors interventions that will improve confined space work leading to reduced errors and improved safety. The specific objectives of this research are three-fold: - analyze current human factors practices as they deal with working in confined spaces at aircraft maintenance facilities and identify human factors interventions to eliminate errors and identify safe work practices, - research best practices by outlining a model program for confined space work that would improve safety, quality of work and human well being by standardizing confined space work for use by the aircraft maintenance industry, and - identify /demonstrate /develop specific tools/interventions to support the confined space model program. The research directly addresses issues that are critical to aviation safety as outlined in the NTSB recommendations, are critical to the FAA, and the general public To ensure that the research is relevant and addresses the needs of the aviation community, it will be pursued with aviation partners that include airlines and aircraft maintenance organizations.2180

Background: Task analyses of aircraft maintenance activity have shown it to be a complex system consisting of several interrelated human and machine components. The linchpin of this system, however, is the human. Recognizing this, the Federal Aviation Administration (FAA) has pursued human factors related research. In the maintenance arena the research has focused on the

mechanic and the aircraft inspector. This maintenance includes scheduling the repair of known problems; replacing items after a certain air time, number of cycles, or calendar time; repairing defects discovered previously, for example from reports logged by pilot and crew or from line inspection, or items deferred from previous maintenance; and performing scheduled repairs. Task analysis of maintenance activities has revealed aircraft inspection and maintenance to be a complex activity requiring above average coordination, communication and cooperation between various personnel to be effective and efficient. This activity is further compounded because a significant portion of the work done by inspectors and maintenance crew has to be performed in limited or confined spaces (e.g., aircraft fuel tank inspection and maintenance work). Previous research in confined space work has shown that working in confined space has the potential of causing: increased damage to critical components/inferior inspection work/poor maintenance repair (e.g., wiring damage), increased risk to human health (Vendetti and Allen, 2000; FAA Aviation News), or all the above. A recent NTSB safety recommendation (A –00-105 through 108) developed in light of the July 1996 TWA 800 Boeing 747-131, N39119 crash referred to the issue of confined space work specifically stating the "need for improved training of maintenance personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions." Thus it is seen that if we are to ensure that confined space work activity is performed safely, effectively and efficiently it is critical that we identify strategies to improve confined space work and provide maintenance personnel with appropriate tools/training in performing confined space work. In response to this need this research will look at confined space work to identify human factor interventions that focuses on improving worker safety, and on improving maintenance and inspection processes. The rationale and need for this research can be summed up as follows: · In aircraft maintenance, confined space work constitutes an area with potential for a large number of maintenance errors and safety violations (see NTSB reports and recommendations) · Errors during confined space work have been documented. Confined space work results in increased stress on the human with potential for causing injury (to the human, equipment, critical aircraft components and all the above). Confined space work conducted as part of inspection, repair and maintenance procedures for fuel tanks pose numerous potential dangers, including fire, explosion, toxic chemical exposure, and oxygen deficiency or enrichment conditions. · Evidence consists of reports of safety violations, incorrect and or improper maintenance/inspection. · Many repair facilities have unclear procedures for confined space work. Even if general guidelines exist, they are not communicated and are not strictly adhered to. In summary, the research is driven by the following specific needs:

1) Previous reports and accidents have revealed that adherence to procedures, awareness, training and organizational support for confined space work is often lacking. Often, there is no detailed program for performing work in confined spaces. Moreover, when one exists employees are not trained, procedures to work are not followed or there exists a lack of awareness. This has resulted in

recent incidences and accidents that have been attributed to confined space work. In light of this situation it is critical that research be conducted which will address the issue of improving confined space work by identifying specific interventions.

2.) This research will directly support recent NTSB recommendations in light of the July 12, 1996 crash of TWA flight 800, Boeing 747-131, N93119 which specifically tasks the FAA and specifically the Aging Transport Systems Rulemaking Advisory Committee with identifying strategies to improve confined space work to reduce incidences of human error (potential wiring damages, damage to critical components) (see A-00-106, A-00-107) and improve safety by looking at training of maintenance personnel and by developing procedures. Moreover the research, also supports earlier NTSB recommendation A-97-70 (A-97-70 Include, in its development and approval of air carrier maintenance procedures and programs, explicit consideration of human factors issues, including training, procedures development, redundancy, supervision, and the work environment, to improve the performance of personnel and their adherence to procedures) which was issued as a result of NTSB's investigation of an accident on May 11, 1996, involving a McDonnell Douglas DC?9?32, N904VJ, that crashed into the Everglades swamp shortly after takeoff from Miami International Airport, Miami, Florida. The airplane was operated by ValuJet Airlines, Inc., as ValuJet Flight 592. 3.) Congressional/Other Interests: This research has the potential to improve confined space work (improves worker safety, reduces errors leading to -- more effective and efficient maintenance). All of which will have a positive impact on quality of maintenance and airline safety – are of interest to Congress, FAA, NTSB, the airline industry and the general public.

Desired Research Outcome: The research will help identify strategies to improve confined space work and provide maintenance personnel with appropriate tools/training in performing confined space work. In response to this need this research will look at confined space work to identify human factor interventions that focuses on improving worker safety, and on improving maintenance and inspection processes. The research will provide the following deliverables for industry use: 1. Model Confined Space Program: outline a detailed program for confined space work that can be implemented by the aircraft maintenance industry. This will serve as a model program for the aircraft maintenance industry, identifying best practices in conducting confined space work. Specifically the program will address the following issues as they relate to: definitions, permits, certification, duties and responsibilities, program management- accountability and responsibility, organizational support, training, information dissemination, procedures – safety practices, implementation, entry/exit, equipment support, purchasing, and other relevant issues) 2. Handbook of Confined Space Work for the Aircraft Maintenance Industry. 3. Tools for Confined Space Work: Outline Training and Awareness programs and workshops for promoting best practices as they relate to confined space work in

the aircraft maintenance environment. 4. Research Dissemination: The results of this research will be disseminated to the aviation community via a number of avenues. These include, but are not restricted to, workshops (FAA sponsored), scholastic publications, presentations at professional conferences (e.g., SAE sponsored conference, Aviation Psychology Conference, and FAA sponsored conferences) and through publications on the internet. In particular, the results of the research will be regularly conveyed to the tem partners through regular debriefing meetings. Most importantly the results of this research will lead to improvements in inspection/maintenance operations and new training procedures.

Output:

Regulatory Link:

Requirement ID: 885

Sponsor Organization: NONE POC:

Requirement Title: Development of Certification Requirements for Visual and NDI Inspection

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Few regulations govern the certification requirements for aircraft inspection personnel. Unlike the uniformity of the cockpit environments, aviation inspection certification requirements are not standardized. This has resulted in the development of adhoc requirements which often are not based on sound principles varying in their level of detail and implementation across maintenance facilities. This has the potential for increased inspection errors and reduced airworthiness. In response, it is necessary to research, develop and implement certification requirements for aircraft inspectors.

Background: In order for the FAA to provide the public with continuing safe, reliable air transportation system it is important to have a sound aircraft inspection and maintenance system. The inspection/maintenance system is a complex one with many interrelated human and machine components. Recognizing this, the FAA has pursued human factors research. In the maintenance arena this research has focused on the aircraft inspector and the aircraft maintenance technician (AMT). Since it is difficult to eliminate errors altogether, continuing emphasis must be placed on developing interventions to make the inspection/maintenance system more reliable and/or more error tolerant. An important component of this system is the human inspector. It is clear that if the human is the linchpin in the system efforts must be made to ensure that the inspector has appropriate proficiency to perform his/her task. Developing certification requirements which will outline the proficiency requirements for the inspector is a good starting point. This research will develop proficiency and certification requirements for visual and NDI inspection, serving as a bench mark for the entire industry.

Output: Technical report outlining proficiency and certification requirements for aircraft inspectors. The result will help achieve the following. It will standardize inspection certification and proficiency requirements leading to improved inspection performance, ultimately impacting safety and reliability of aircraft inspection and maintenance operations. It will standardize the inspection process providing an industry-wide benchmark for inspection certification, proficiency and training Potential to reduce inspection inspector errors, improve regulatory

compliance, increase completeness and accuracy of inspection leading to more effective and efficient inspection. This will improve both safety and reduce inspection costs. All of which will have a positive impact on quality of maintenance and airline safety and are of interest to Congress, FAA, NTSB, the airline industry and the general public

Regulatory Link:

Requirement ID: 795

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Development of Handbook of Human Factors in Airframe and Engine Inspection Reliability

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: This research is necessary to ensure that the aviation inspection reaches the highest possible of level of reliability. Incidents such as Aloha B-737 failure, the Sioux City DC-10 crash and the Pensacola MD-80 damage have shown that inspection is not always reliable and that the human element in theinspectionn system is a primary cause of concern. Inspection managers and inspectors themselves are often unaware of the importance of human factors, and thus do not design inspection facilities, training systems or procedures to minimize the negative impact of human performance on inspection reliability.608

Background: Development of handbook applying what is known about human factors in inspection to improve engine and airframe reliability. Product: Handbook of human factors in aviation inspection to provide a single source for industry. Topics will include design of training programs, design of inspection equipment, the inspection environment, and the design of operating procedures using human factors knowledge and data. Driver: AVR Performance Plan (2000) Iniative 1, NTSB Recommendation98-1/FAA National Aging Aircraft Progam Plan/supportive of AFS-300/ANE-105/AFS-600 Initative Deliverable: Handbook for airframe & engine inspections

Output:

Regulatory Link:

Requirement ID: 786

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Development of Standards for AMT Certification Training Using Distance Learning

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: The efficiency and effectiveness of the knowledge delivery is being lost. AMT training is limited by regulation to the use of traditional delivery methods. This has contributed to the decline of persons entering the aviation maintenance career. High school students can not obtain aviation training until graduation, unlike other careers such as automotive maintenance, which provides introductory training to high school students in a manner consistent with high school scheduling requirements. The early introduction into the automotive industry creates interest and motivates students to seek automotive careers. Authorized distance learning may also provide military personnel with the ability to complete AMT training prior to discharge allowing for a faster, more efficient transition in to civilian careers.819

Background: Models shall form the basis for curriculum certification guidance to be utilized by AMT training providers and FAA Airworthiness Inspectors Product: Development of standards for the delivery of AMT certificate training using distance learning technology. Driver: Regulatory FAR Part 147; AVR Performance Plan(2000) Iniative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Progam Plan Deliverable: Development of Distance Learning Standards(Eval & Validate)

Output:

Regulatory Link:

Requirement ID: 784

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Development of the AMT Training Models

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Training requirements for the AMT were developed in 1968. Except for minor revisions in 1993, these requirements have remained unchanged. Technological advance in aircraft, powerplants and their systems have vastly outpaced the training requirements for entry-level AMTs. This gap has created problems for the aviation industry in finding adequately trained technicians.372

Background: Specific student performance objectives (SPOs) to correspond to curriculum topics Product: Develop curriculum models for the A&P schools and AMT's for highly skilled workforce and develop performances level to meet requirements to work on newer more advanced aircraft. Driver: Regulatory FAR Part 147; AVR Performance Plan(2000) Iniative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Progam Plan Deliverable: Development of Distance Learning Standards(Eval & Validate)

Output:

Regulatory Link:

Requirement ID: 883

Sponsor Organization: ATA Maintenance Human Factors Subcom POC:

Requirement Title: Effect of Work Interruptions on Aircraft Inspector Performance

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: task analyses of aircraft inspection and maintenance has revealed work interruptions to be detrimental to inspection and maintenance performance. It has shown to lead to omissive, commissive and sequence errors.It is clear that strategies need to be identified and protocols need to be developed to mitigate the ill effects of work interruptions.

Background: Evaluation and controlled studies are needed that focus on the impact of work interruptions on performance. Drawing from the results of these controlled studies, interventions can be identified to prevent the ill-effects of these interruptions.

Output: Research Report that outlines the results of controlled studies. Interventions to prevent errors due to work interruptions. Protocol for use of aircraft inspection and maintenance types.

Regulatory Link: ATA Report 2002

Requirement ID: 920

Sponsor Organization: AFS-300 POC: Rusty Jones

Requirement Title: Effects of fatigue/vigilance/environment on inspectors performing Fluorescent Penetrant and/or Magnetic Particle Inspections

Funded Requirement:

- FY02: No
- FY03: Yes
- FY04: Yes
- FY05: Yes

Requirement Statement: As a result of the National Transportation Safety Boards investigation into the July 6, 1996, uncontained engine failure in Pensacola, Florida, of Delta Air Lines flight 1288, a McDonnell Douglas MD-88, Safety Recommendation A-98-17 was issued to the FAA. This safety recommendation requests that the FAA, "conduct research to determine the optimum amount of time an inspector can perform nondestructive testing inspections (NDI) before human performance decrements can be expected." A research project studying NDI as a whole is very expensive, time consuming and hard to quantify, however the two primary methods of NDI that lend themselves to such a study are Liquid Penetrant and Fluorescent Magnetic Particle Inspection.

Background: Inspectors performing these two methods are expected to scan wide areas of critical parts looking for small defects. The inspector viewing these parts must work for extended periods of time in a dark room using ultra violet light to accomplish these inspections. It is well documented that the probability of detecting small defects decreases as time on the job increases. Does the working environment; i.e. working in the dark, low expectation of finding critical defects, further magnify this vigilance decrement for inspectors performing Liquid Penetrant or Fluorescent Magnetic Particle Inspections?<p>

Conduct empirical research to study the effects of fatigue/environment on the vigilance decrement of inspectors who perform Liquid Penetrant or Fluorescent Magnetic Particle Inspections as their primary work function. Determine the optimum time that can be realistically spent performing these two inspection methods before detectability is significantly decreased.

Output: A "Best Practices" document to inform the aviation community of the potential problems associated with fatigue in combination with environment when performing these two inspection processes. This can serve to educate the NDI community, and emphasize the need for regulating the time and individual spends performing these processes.

Regulatory Link: The National Transportation Safety Board (NTSB) issued Safety Recommendation A-98-17 as a result of the Delta/Pensacola accident.

Requirement ID: 782

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Evaluation of Aviation Maintenance Working Environments, Fatigue and Maintenance Errors/Accidents

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Few regulations govern the working environments of aviation maintenance personnel. Unlike the uniformity of the cockpit environments, aviation maintenance workers perform their tasks in a wide variety of environmental conditions. Some of these conditions have been found to accelerate the onset of fatigue, decrease job performance, and increases human error and the risk to aviation safety. Profile AMT task environments and model data to predict conditions that are related to aviation maintenance errors.509

Background: Develop methods and guidelines that can be used to reduce fatigue producing factors in the aviation maintenance environment that will reduce maintenance errors/accidents and increase maintenance safety. Product: Fatigue profile model related to risk management of aviation maintenance errors. Driver: NTSB recommendation A-97-71/Petition for rulemaking/GAO report/Intermodal/AOA Performance Plan G-101.f/AVR Performance Plan (2000)/FAA National Aging Aircraft Progam Plan Deliverable: Report and regulatory guidelines (Audit)

Output:

Regulatory Link:

Requirement ID: 787

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Evaluation of the Integrated AMT/AMT-T Curriculum Alternative Method Implementation and Assessment

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Legislation mandates research on future training requirements on projected changes in regulatory requirements for aircraft maintenance and powerplant licenses158

Background: Develop, implement, and assess the integrated curriculum using alternative training methodologies for AMT technology skill transfer and application that demonstrates student performance-outcome based on curriculum, such as team-building, human factors, error control and analysis, computer and technical material, multimedia based educational/learning modules for active learning to test whether curriculum meets educational objectives and student performance objectives Product: Development of model program that can be replicated in other technical colleges Driver: Congressional Mandate/Agreement between ARA-2 and Sen. Hollings/; Project completion after 2001 Deliverable: Validation/Report/Guidance/Congress

Output:

Regulatory Link:

Requirement ID: 792

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Evaluation of US Military AMT Training and Experience Applicability to Training, Qualification, and

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Determine applicability of military training and experience based upon FAA requirements. Identification and development of these requirements necessary to bridge the differences for training military AMTs. The objective of this research is to develop an articulation document which will allow recognition of military aviation maintenance training and experience toward the award of FAA A&P certification. Any discrepancies that may exist between the military training and the FAR Parts 65 and 147 requirements will be identified530

Background: Develop standards that will provide the means to establish a validation process by which the FAA can establish certification credit for military training, qualifications and experience Product: Guidance and curricula guidelines for military to administer the appropriate AMT written oral and practical examination, validation of qualified, competent personnel Driver: Regulatory/FAA/DoD/DOL Interagency Task Force (Pentagon Interest/AOA) /FAA National Aging Aircraft Progam Plan/Project completed Deliverable:

Output:

Regulatory Link:

Requirement ID: 918

Sponsor Organization: AFS-300 POC: Les Vipond

Requirement Title: General Aviation Alaska Maintenance Accidents

Funded Requirement:

- FY02: Yes
- FY03: Yes
- FY04: No
- FY05: No

Requirement Statement: NTSB data and the generally high GA accident rate in Alaska indicate that this issue must be studied to determine if the overall accident rate can be reduced by reducing the maintenance error rate if maintenance issues are determined to be a significant issue in Alaska accidents.

Background: Determine the role of maintenance in the high general aviation (GA) accident and incident rate in Alaska. Review for the last 10 years NTSB and FAA GA accident and incident data for the entire country to determine the leading maintenance factors that contribute to GA accidents and incidents for aircraft operating both in Alaska and the rest of the country. Compare the Alaska data to the maintenance contribution accident data for the rest of the U.S. Using this data, determine if maintenance errors are a contributing factor or a direct causal factor to accidents to a greater degree in Alaska than in the rest of the country. If data indicates maintenance errors have a greater contribution to accidents in Alaska when compared to the rest of the U.S., determine the particulars. Error classification factors present in Alaska may include: 1)Extreme climates, 2)Limitations on Parts and equipment availability, 3)Aging aircraft fleet, 4)Severe operational demands, and 5)General lack of other maintenance resources.

Output: Research report, and documentation required to support development of advisory circulars or safety related training on CD or video to be used by the FAA Safety Program.

Regulatory Link: Parts 91, 43, 121, 135, 145

Requirement ID: 796

Sponsor Organization: AFS POC: Jean Watson

Requirement Title: General Aviation Maintenance Human Factors: Taxonomy of Human Error At-Risk Conditions in General Aviation

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Error in General Aviation (GA) maintenance can be the result of maintainer acts, working conditions, maintainer conditions, supervisory conditions or even organizational climate. Variations in work settings from single person shops to relatively large maintenance facilities present unique challenges for GA maintenance human factors research. A description of conditions conducive to errors is needed to provide a systematic framework of research.448

Background: A taxonomy to support accident / incident investigation, and assessment of the individual, organizational and training issues that influence the performance of GA maintenance personnel. Product: Development of a model that can be used across GA maintenance shops and flight lines to identify human factors concerning at risk conditions associated with GA maintenance incidents. Driver: CAMI in-house resources Deliverable

Output:

Regulatory Link:

Requirement ID: 638

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Human Error Risk Analysis in Aviation Maintenance and Flight-line Operations

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Current systems to capture human error in aviation maintenance have mixed reviews. Most focus on proximate causes and immediate circumstances, while others use a task analytic approach to examine distal events. However, these approaches do not uncover all of the "latent conditions" such as teamwork or inadequate supervision that effectively "set the stage" for "active failures" to occur. Furthermore, they do not provide for human error risk assessments based upon exposure, severity of outcome, number of operations, etc.527

Background: A taxonomic framework suitable for use as a training vehicle, investigator reference, database structure, etc. An analysis of a range (major to minor) of Part 121 organizational mishaps obtained from the commercial airlines, rework facilities, transient lines, etc. A documented risk assessment process suitable for Part 121 organizations A human factors risk assessment for problems identified in the Part 121 analyses Product: This research will provide a multi-dimensional framework to support the investigation, reporting, and analysis of commercial aviation maintenance incidents. It will also generate a process to identify human factors problems, determine present trends, and estimate associated risks in commercial aviation. Driver: AOA Performance Plan(2000) G-1.0.1.h/FAA Strategic Plan(2000) Iniative 47: ASAP AC 120-56/FAA National Aging Aircraft Progam Plan Deliverable: Risk Analysis

Output:

Regulatory Link:

Requirement ID: 794

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Human Factors Best Practices in Engine Inspection

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: This research is necessary to ensure that the inspection of engine components, particularly rotating components, reaches the highest possible of level of reliability. Incidents such as Sioux City DC-10 crash and the Pensacola MD-80 damage have shown that engine component inspection is not perfectly reliable and that the human element in the inspection system is primary cause of concern.390

Background: Development of improved training schemes and procedures for a variety of engine inspection tasks to reduce the overall incidence of inspection error for critical components. Product: Report with detailed human factors analysis and recommendations for improvement of inspection reliability of engine components. Driver: AVR Performance Plan (2000) Iniative 1, NTSB Recommendation98-1/ FAA National Aging Aircraft Progam Plan/supportive of AFS-300/ANE-105/AFS-600 Initative Deliverable: Report/Detailed recommendations for improvement in inspection reliability

Output:

Regulatory Link:

Requirement ID: 884

Sponsor Organization: ATA Maintenance Human Factors Subcom POC:

Requirement Title: Implementing a Standardized Shift Protocol to Improve Work Transfer

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: This research will implement earlier work on shift-change to demonstrate effectiveness of a standardized protocol in reducing shift change errors and improving efficiency.

Background: Shift change has been widely reported as a cause of several errors/accidents in the aircraft maintenance industry (see FAA, 1991; FAA ,1993; Hobbs and Williamson, 1995; and the recent Continental Express crash). This can be attributed due to a lack of a well defined shift change procedures for use by the aircraft maintenance industry. In response to this need, industry has developed ad-hoc measures and general guidelines to assist various personnel involved in the shift change process. This has resulted in various organizations developing their own internal procedures which vary in their level of instruction/detail. Because of this shift change procedures are not standardized across the industry. Moreover, they are often not based on sound principles of human factors design. Hence, there exists a need to look at the shift change process.

Output: Final report will provide data on errors and improvements in efficiency and effectiveness in implementing a standardized shift change protocol.

Regulatory Link:

Requirement ID: 886

Sponsor Organization: NONE POC:

Requirement Title: Improving Information Flow To Support Inspection and Maintenance Operations

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: The research will address issues related to supporting information systems design so that inspectors and mechanics can perform tasks effectively and efficiently while minimizing errors.185

Background: Information to inspectors and mechanics on the hangar floor comes from diverse sources (e.g., feedforward, feedback, documentation, management, ADs, etc.). (FAA, 1991; 1993 and 1995. It is critical that a system exists that presents this information in an integrated and usable format. Research is needed that will address issues related to how this information is integrated, made available, updated and presented.

Output: Research will yield a technical report outlining an information support system for use by maintenance mechanic and inspectors that implements optimum use of information based on process mapping techniques

Regulatory Link:

Requirement ID: 804

Sponsor Organization: AFS, ATA Maintenance Human Factors Subcom POC:

Requirement Title: Increase Reliability of Wiring Inspection

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: The proposed research directly benefits the Aging Systems initiatives in the Federal Aviation Administration (FAA) and Air Transport Association (ATA) aimed at improving the safety of transport aircraft wiring systems. The end point of all rule-making and technology is the inspector who must perform wiring systems inspections with high reliability. Any techniques that enhance the reliability and predictability of inspection performance will increase public safety and ultimately help operators in more efficient use of inspection resources. There is a nationally expressed need to translate the rulemaking activity into effective inspection. This proposal addresses issues of inspector training, factors affecting reliability and help in implementation of research findings. The work builds on a continuous program of involvement with human factors issues in airframe and engine inspection dating back to the Aloha incident of 1998. The proposal covers four Research Objectives: 1. Build on the experience of detailed analyses of a variety of inspection techniques to better characterize wiring inspection and its human factors implications for reliability. 2. Examine experimentally the factors expected to enhance or degrade visual and NDI inspection of wiring systems. This will enable the design of job aids, training or modified inspection intervals depending on the specific factors concerning the defect condition and the environment in which that condition is embedded. 3. Determine the extent to which correlated cues can be used to enhance visual inspection of wiring systems. The Intrusive Inspection report showed that while some defect conditions are not directly detectable, other manifestations correlated what those conditions may be. This determination will form the basis of model training programs and job aids to improve detection reliability. 4. Provide practical best practices for enhancing wiring inspection to cover training, job aids, environment design and documentation design and test selected practices for both effectiveness and acceptability.2098

Background: Sponsor Need Description: The National Transportation Safety Board (NTSB), from its analysis of the TWA 800 accident (Safety Recommendations, Sept. 2000), made a number of recommendations concerning wiring safety, including "The need for improved training of maintenance personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions." In addition, the FAA and ATA have made extensive

recommendations on improved wiring inspection as parts of the Aging Transport Systems Rulemaking Advisory Committee (ASTRAC) and the issuance of ATA Specification 117 Wiring Maintenance Practices/Guidelines. Finally, the Assistant Inspector General for Auditing (USDOT) in testimony on October 5, 2000 noted that "… it is uncertain when revised maintenance programs, new training programs, and especially new technology can be implemented." Initiative 8 under Performance Goal 1 of FY 1999 AVR Performance Plan calls for the FAA to "establish requirements for training aids in wiring installation practices for certification engineers and designees" Desired Research Outcome: From this activity will come three specific sets of outcomes as noted in 5 above. First, job aids, training or modified inspection intervals will be specified depending on the specific factors concerning the defect condition and the environment in which that condition is embedded. Second, model training programs and job aids to improve detection reliability will be developed. Finally, the project will provide validated practical best practices for enhancing wiring inspection to cover training, job aids, environment design and documentation.

Output:

Regulatory Link:

Requirement ID: 862

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Language Barriers Result in Maintenance Deficiencies

Funded Requirement:

- FY02: Yes
- FY03: Yes
- FY04: Yes
- FY05: No

Requirement Statement: To determine whether the growing number of maintenance and inspection personnel who possess a wide range of non-native English reading, writing, and speaking abilities are more inclined to commit an error than personnel whose native language is English.253

Background: The existence of maintenance and inspection personnel whose native language is not English suggests that language barriers may be causing performance errors. Within the airline maintenance environment there is an increasing trend towards outsourcing. Phillips (2002) in Aviation Week and Space Technology notes "…the move by airlines to slash costs is driving outsourcing to new levels." In a related paper, Sparaco (2002) sees the formation of global MRO (Maintenance and Repair Organizations) networks involving US and foreign airlines as well as repair stations. In addition to offshore MROs, there are many within the USA where non-native English speakers form part of the labor pool. There is an increasing population of non-native English speakers, some of whom can be employed as mechanics or inspectors. Again, the difficulty of moving between languages creates an additional potential for error. An earlier report on human error in repair stations from the FAA's Human Factors in Maintenance and Inspection initiative also showed the trend toward outsourcing (Drury, Wenner and Kritkausky, 1999). What did not emerge specifically from this report was that many Part 145 facilities are not located in the USA, creating some potential for errors where the staff does not have English as their native language. The language of aviation is primarily English, both in operations and in maintenance. An Aviation Maintenance Technician (AMT) must pass their examinations in English, and all maintenance documentation in use at the Federal Aviation Administration (FAA) approved facilities is in English. This poses a second-language or translation burden for Non-Native English Speakers (NNESs) that can potentially increase their workload, their performance time or their error rate, or even all three measures. In a 2001 report to the Secretary of Transportation by the Aircraft Repair and Maintenance Advisory Committee, many of these issues were raised in considering changes to the domestic and foreign FAR Part 145. The issues concerned the qualifications and standards for personnel, makes one conclusion: "Although new Part 145 requires supervisors, inspection personnel, and personnel authorized to approve an article for return to

service to be able to read, write and understand English, there is some concern that communication, particularly with regard to the ability to speak English, may be a problem in foreign repair stations. However, there is no data to indicate that there is a problem in this area." and a recommendation (Drury, Wenner, and Kritkausky, 1999) that: "The FAA should establish a method for determining whether language barriers result in maintenance deficiencies." This requirement is a direct response to these concerns that NNES, in repair stations in the USA and abroad, may be prone to an increased error rate that could potentially affect airworthiness.

Output: Final report will provide refined estimates of error frequency, patterns of error types, effectiveness of intervention strategies and recommendations for FAA action to mitigate language related errors

Regulatory Link: Secretary of Transportation requirement (1/29/01)

Requirement ID: 636

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Measuring the Effectiveness of Error Investigation and Human Factors

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Reduce errors in aviation maintenance and test effectiveness of human factors interventions. Measure how thoroughly airline maintenance personnel investigate errors or incidents and measure the effectiveness of Human Factors interventions using an error-investigation methodology.283

Background: Incident-based methodology to test effectiveness of human factors interventions. Effectiveness is measured by how thoroughly airline maintenance personnel investigate errors or incidents. Baseline data will be collected on samples of professional investigators (Quality Assurance investigators, human factors professionals, aviation maintenance managers and foreman, and AMTs). Measure how skilled these groups are and what bias they show Product: Specific measures of how training programs and the investigation tools provide usable knowledge to the investigators Driver: AOA Performance Plan(2000)G-1.0.1.h /FAA Strategic Plan(2000) Iniative 47: AASAP AC 120-66/NTSB interes/tFAA National Aging Aircraft Progam Plan Deliverable: Development of methodology for investigation errors/accidents, measurement of event tree/baseline data, report

Output:

Regulatory Link:

Requirement ID: 785

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Optimizing Maintenance Technician Training and Certification

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Technician training and certification has not kept pace with the requirements of the industry, the FAA sponsored an ARAC project to revise the regulation, the process continued for over 8 years and resulted in an NPRM that the industry generally believed was too complex and not workable. CFR 14 PART 65 underwent regulatory revision that resulted in an NPRM issued November 1998.The NPRM received more than 2000 comments, mostly negative, commenters primarily objected to the NPRM complexities, the amount of regulatory requirements contained in advisory material a two tier technician certification system, and the amount of training specified for technicians. The FAA has three objectives in technician certification, conduct a recurring census of technicians, increase the training and certification requirements, and focus on air transportation issues. The FAA requires a study to achieve those objectives without introducing the significant complexities that developed in the original NPRM.99

Background: The desired outcome would be a study that would provide appropriate background to FAA to develop a realistic regulation in accord with the majority of commenters and achieve the FAA certification goals. Product: Report detailing various options to respond to FAA requirements as stated above and to respond to the public comments received in response to the original NPRM. This report will form the core of the FAA project to revise the regulation [Part 65] specifying the requirements for technician certification. Driver: Regulatory FAR Part 65; AVR Performance Plan(2000) Iniative 35, NTSB Recommendation A-89-56/FAA National Aging Aircraft Progam Plan Deliverable: Report/Formation of core revision of Part 65 specifing requirements for AMT certification

Output:

Regulatory Link:

Requirement ID: 635

Sponsor Organization: AVR POC: Les Vipond

Requirement Title: Proactive Safety Assessment

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Assess error generation to more effectively assess the propensity for future errors within maintenance organizations and allocate organizational resources in their prevention. Current methods utilized within airline maintenance industry are restricted to reactive measurement of error causation.296

Background: Develop methodologies similar to those used effectively in the nuclear and chemical industries to assess organizational factors and latent conditions which cause the majority of errors within aviation maintenance Product: Development of generic audit system which indicate organizational factors and latent conditions which predict potential maintenance errors that could be implemented by various maintenance organizations. Driver: AOA Performance Plan(2000) G-1.0.1.h /FAA Strategic Plan(2000) Iniative 47: A ASAP AC 120-66/FAA National Aging Aircraft Progam Plan Deliverable: Safety Audit/General Failure/latentent/predispose errors

Output:

Regulatory Link:

Requirement ID: 781

Sponsor Organization: AFS POC:

Requirement Title: Reducing FOD through Improved Human Performance: Best Practices

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: In terms of damaged equipment and scheduling delays, Foreign Object Damage (FOD) accounts for a significant amount of industry costs. Boeing estimates yearly FOD costs to exceed $4 billion. Though some research has been performed that examined human factors precursors to ground damage, relatively little effort has been dedicated to organizational-level (organizational culture) precursors of FOD specifically. This research seeks to establish a baseline for further human factors investigations related to FOD through root cause trending tailored to cultural preconditions. Though FOD prevention programs currently exist, there seems to be little evidence that these programs were developed based on a well-developed need analysis. This project will address that gap by identifying potential contributory root cause factors that lead to FOD and develop a series of recommendations and/or corrective actions based on generalized human factors knowledge and current industry best practices.997

Background: A recent initiative was undertaken by industry to identify and rank potential catastrophic events contributed by human error. The survey ranked Foreign Object Damage (FOD) as the most likely potential ground-based cause that could lead to a catastrophic event. The exploratory nature of this project requires the research team to first establish the parameters of FOD and its human factors contributors. This project will identify potential causal and contributory factors that lead to FOD and develop a series of recommendations and/or corrective actions based on generalized human factors knowledge and current industry best practices. First, establishment shall be made with industry partners in order to sample a valid set of data. Concurrently, data will be gathered and an assessment of will be made of as many FOD-prevention programs as possible to assess the current state of FOD research and prevention. Second, define FOD and differentiate it from other forms of Ground Damage; also examine currently available mishap databases for FOD trends by utilizing accident (or scenario) analysis methodology. Examples of data trend analysis include examining trends based on work setting (hanger vs. line) and look for similarities/differences. Third, the project shall assimilate data related to the cost of FOD each year. Fourth, based on data from multiple industry

partners, the project shall look for significant differences in FOD trends and investigate their current FOD strategies. From these data, create a generalized set of industry "best practices" will be created based on these findings as well as other basic human factors research. The primary benefit of this research is its focus on identifying human factors precursors to FOD and the subsequent creation of generalized best practices or corrective actions through human factors interventions. The primary beneficiaries are industry maintenance organizations (reduced costs) and the traveling public (through improved general safety and alleviation of scheduling delays through reduction of FOD)

Output:

Regulatory Link:

Requirement ID: 637

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Reducing Installation Errors in Heavy Maintenance

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Use applied research to reduce a selected category of error by 50%. Show that FAA research can offer cost effective and quantifiable solution142

Background: Creation of specific actions and interventions to be used by the aviation maintenance industry to reduce errors of omission. Product: A listing of interventions to minimize human error in installation during maintenance and inspection. A report showing the percent of error reduction achieved. Driver: NTSB Recommendation 89-56/FAA National Aging Aircraft Progam Plan Deliverable: Report/interventions

Output:

Regulatory Link:

Requirement ID: 861

Sponsor Organization: AFS POC: William O'Brien

Requirement Title: Review Amateur-Built Aircraft Accident/Incidents

Funded Requirement:

- FY02: Yes
- FY03: TBD
- FY04: No
- FY05: No

Requirement Statement: To determine the causal factors (e.g., human factors, construction, operation, maintenance and other factors that cause accidents) surrounding the high accident and incident rate for amateur-built aircraft per 100,000 hours of operation. This research will then be compared against similar General Aviation accident and incidents.331

Background: NTSB data and special reports such as the John Denver accident list causal factors and probable cause. The purpose of this research is to collate and identify factors in at least the following areas. Human Factors, Construction, Operation, Maintenance and Other Factors that cause accidents. This research should be compared against similar General Aviation accident and incidents. The report should summarize the causal factors, findings and make recommendations to improve safety.

Output: Research report and documentation will be used to create an Advisory Circular or Safety related training on CD or video to be used by the FAA Safety Program. * Determine frequency and types of causal factors attributable to human factors, construction, operation, maintenance, and other factors in amateur-built aircraft accidents and incidents. * Compare this list to similar General Aviation maintenance-related accident and incidents. * Determine frequency and types of causal factors attributable to human factors, construction, operation, maintenance, and other factors in general aviation accidents and incidents. * Compare this list to similar General Aviation accident and incidents.

Regulatory Link: Information will be helpful to develop tools to reduce amateur-built aircraft accidents and incidences and development of guidance material for the new sport pilot NPRM FAA Docket –20001-11133 Notice No 02-03).

Requirement ID: 780

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Root Cause Analysis of Rule Violations by AMT's

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: The FAA enforcement action data for the first three quarters of 1999 shows that 79 certificate actions resulted in approximately $2.25M of fines due to maintenance violations. Such certificate actions are usually initiated by a letter of investigation (LOI) issued to the mechanic responsible for the maintenance action that potentially impact the airworthiness of the aircraft being maintained which could lead to an incident or accident. From that point forward, substantial resources from the FAA and the industry are spent in these investigations. The research focuses on the causal factors for alleged rule violations by AMTs. Such analysis is expected to identify individual and organizational factors that lead to incidents or accidents in the future. This is a proactive approach to identify root causes or latent systemic failures early enough so that serious mishaps are avoided. By focusing on the rule violations, the most significant root causes are addressed, making change implementation more safety oriented and cost effective.1043

Background: Detailed analysis of the individual and organizational factors contributing toward rule violations by AMTs. The mapping of root causes of these violations will provide the FAA and airlines with specific target areas for improvement. Product: Identification of the most significant factors that are responsible for rule violations. Develop appropriate guidelines that will manage and mitigate these factors and reduce the instances of rule violations. Driver: FAA AFS Enforcement (E.I.R.)/FAA National Aging Aircraft Progam Plan Deliverable

Output:

Regulatory Link:

Requirement ID: 921

Sponsor Organization: AFS-300 POC: Les Vipond

Requirement Title: Sport Pilot Maintenance Training

Funded Requirement:

- FY02: No
- FY03: Yes
- FY04: Yes
- FY05: No

Requirement Statement: The NPRM for sport pilot aircraft permits owners to move their aircraft and its associated maintenance requirements into a new category with reduced standards of training for those persons performing maintenance on aircraft in that category. Since the complexity of the aircraft has not been reduced, the new maintainer standards must be evaluated to determine if they are adequate.

Background: The current NPRM for Sport Pilots specifies certain training requirements for persons performing maintenance and inspection on sport aircraft. The requirements for training in the NPRM may not be of sufficient rigor to meet the regulatory requirements in force currently for similar aircraft. Project would determine the adequacy of the NPRM training proposal, and if appropriate, suggest changes to the NPRM. The project would compare the NPRM proposal to the Part 43 Appendix provisions for pilot preventive maintenance, Part 147 AMTS training, and Part 65 AMT privileges. These provisions would be compared to those performed on aircraft of similar complexities and then mapped against the maintenance task classification schemes described in the Northwestern University Job Task Analysis of the AMT Occupation.

Output: Research report to support development of an advisory circular or rulemaking efforts to identify improvements to the Sport Pilot NMRM, maintenance or training procedure requirements.

Regulatory Link: Parts 91,65,147,43

Requirement ID: 783

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: The Impact of Professional, Organizational, and National Cultures on the Safety Climate in the Aviation

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: Significant research needs to be accomplished on developing the concepts and measurements of "professionalism" and mutual trust in a professional environment because it is postulated to be the key in building safe virtual organizations. Such measures must transcend the traditional boundaries of national and organizational cultures not only because aviation is an international business, but also because AMTs in the United States are multiethnic.449

Background: Currently, it is known that differences in professional, organizational, and national cultures exist in aviation maintenance. Their inter-relationships and the consequent effect on the overall safety culture are not known. This research will provide a further understanding of the concept of "safety culture" in aviation maintenance and identify the positive and negative influences on that culture. Product: Development of profiles of the safety culture at the maintenance facilities of major U.S. airlines. These profiles will constitute professional, organizational, and national attributes which contribute to safety culture. The inter-relationships and effects of changes in the constituent elements on the safety culture will be explored. Driver: Safety/NTSB/MRM followon AVR Performance Plan (2000) Iniative 34/FAA National Aging Aircraft Progam Plan Deliverable: Development of profiles/elements of safety culture

Output:

Regulatory Link:

Requirement ID: 891

Sponsor Organization: NONE POC:

Requirement Title: The Use of Advanced Technology to Support Aircraft Maintenance Technology Curriculum

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: This research will extend earlier work on use of human factors and advanced technology into a national program that integrates distance learning and advanced technology tools to implement a state-of-the-art aircraft maintenance technology curriculum.250

Background: Earlier work pursued under the auspices of FAA funded research effort (Gramopadhye et al 2000), current work in use of virtual reality pursued by Clemson University with funding from NASA (Vora, Duchwoski, and Gramopadhye, 2001), and current efforts by Parks College to provide an internet-based aviation safety management program will provide the foundation to develop and implement a state-of-the-art aviation maintenance technology curriculum. In addition, this approach addresses the objectives listed below in the Goldsby and Soulis (2002) report to FAA's Flight Standards Division outlining the updating and revision of the Federal Aviation Regulations (FAR) for maintenance personnel training and certification, including previous work on this issue (FAA, 1999[1], 1999 [2], 1999[3] and FAA, 2000). The specific FARs addressed are 14 CFR, PART 65, SUBPART D: Certification: Airmen other than flight crewmembers and PART 147: Aviation maintenance technician schools: · An increased focus on inspection and inspection systems, especially for aging aircraft · An increased focus on new technology, including complex aircraft and systems maintenance processes · An increased emphasis on composite and metal structures · An increased effort on using computer based technology to support aircraft maintenance technology curriculum · Program flexibility to accommodate regional preferences to promote greater student enrollment · An inspection module as a "capstone" project

Output: Technical report outlining the elements of the curriculum, support materials, a prototype of courses ready for implementation. This project will be completed over a three-year period.

Regulatory Link:

Requirement ID: 890

Sponsor Organization: NONE POC:

Requirement Title: Trust, Professionalism, and Ethics in Aviation Maintenance

Funded Requirement:

- FY02: No
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: This research will document the effects of interpersonal trust, professionalism, and ethics in aviation maintenance tasks. Emphasis will be placed on airworthiness and safety of maintenance tasks, as influenced by operational pressures.236

Background: Previous reports by Taylor and Patankar (2002); Goglia, Patankar, and Taylor (2002) have emphasised that interpersonal trust and professionalism play a vital role in post-maintenance airworthiness of aircraft. Research by Patankar and Taylor (1999) has already demonstrated that appropriate decision-making techniques can facilitate ethical as well as safety-based problem solving.

Output: This research will document specific cases that illustrate the challenges faced by maintenance professionals throughout the country in holding safety as a priority over performance. Additionally, the research will identify specific decision-making tools as well as interventions that can be implemented at individual and organizational levels.

Regulatory Link:

Requirement ID: 863

Sponsor Organization: AFS POC: Les Vipond

Requirement Title: Using Technology to Support Inspector Training

Funded Requirement:

- FY02: Yes
- FY03: Yes
- FY04: Yes
- FY05: Yes

Requirement Statement: To demonstrate how advanced technology can be used for inspection training and reducing errors for the general aviation industry128

Background: Reduce inspection errors and improve GA inspection performance, ultimately impacting safety and reliability of GA aircraft inspection and GA maintenance operations. · Standardize the GA inspection training process providing an industry-wide benchmark for inspection training. · Alleviate problems inherent to OJT and can be combined with existing GA training programs to facilitate consistency in inspection training, provide adaptive training and support record keeping and performance monitoring.

Output: This research will provide the general aviation industry with a benchmark for inspector training. Evaluation and validation studies will be delivered that focus on the impact of inspector training programs in minimizing inspector errors and standardizing the inspection training process.

Regulatory Link: none

Requirement ID: 801

Sponsor Organization: AFS POC: Rusty Jones

Requirement Title: Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components

Funded Requirement:

- FY02: Yes
- FY03: No
- FY04: No
- FY05: No

Requirement Statement: At a minimum, the goal of this project is to determine the proper standards to be employed in the visual acuity testing of persons inspecting aircraft and aircraft components. This material will then be set forth in an Advisory Circular or eventually be included as an amendment to the Federal Aviation Regulations. This project would involve, as a minimum, the following: 1. Determine vision parameters that include but not limited to: visual acuity, stereo acuity, color vision, peripheral vision, near and far focal length, contrast sensitivity, visual fields, eye disorders, eye diseases, medication effects, corrective lenses, colored lenses, and age effects. 2. Determine who will be required to meet these minimum standards for performance of their job function. 3. Determine the time interval when vision tests will be administered. 4. Establish written procedures to provide guidance to organizations that will need to setup programs for administering and documenting the eye examinations. 5. Determine if these standards should be included in an Advisory Circular or as an amendment to the Federal Aviation Regulations.1138

Background: Over fifty percent of all Advisory Directives issued, require inspection, yet there is no standard to determine how well or if an inspector can see. Part 67 of the Federal Aviation Regulations provides requirements for visual acuity testing for aircraft pilots for first, second and third class medical certificates. There currently is no requirement to assure that persons performing maintenance or inspection of aircraft meet a minimally acceptable vision requirement. Various programs for the certification of persons performing Nondestructive Testing require vision examinations prior to certification. These requirements are neither uniform nor standard throughout the industry. There currently is no requirement for a person performing visual inspections to be tested for visual acuity or color perception. There have been several aircraft accidents where large cracks and/or corrosion were not detected during visual inspections. The National Transportation Safety Board (NTSB) has cited the failure to visually detect detectable cracks as the probable cause of these accidents. Examples of these are as follows: NTSB 98/01, Aircraft Accident Report, Uncontained engine failure, Delta Airlines, Flight 1288, McDonnell Douglas MD-88, N927DA, Pensacola, Florida, July 6, 1996. A crack with a total

surface length of 1.36 inch in the front compressor hub of a Pratt & Whitney JT8-219 engine, was not detected during Visual and Fluorescent penetrant inspections. NTSB 09-06, United Airlines Flight 232, McDonnell Douglas DC10-10, Sioux Gateway Airport, Sioux City, Iowa, July 19, 1989. A crack with a total surface length of 0.498 inch in the stage 1 fan disk in the no. 2 CF6-6 engine was not detected during Visual and Fluorescent penetrant inspections. The NTSB determined, based on a count of the fatigue striations that at least two inspections had been accomplished after the crack had reached a detectable length. NTSB 89/03, Aloha Airlines, Flight 243, Boeing 737-200, N73711, near Maui, Hawaii, April 28, 1988. The NTSB determined that the cause of this accident was the failure of the Aloha Airlines maintenance program to detect the presence of significant disbonding and fatigue damage which ultimately led to the failure of a lap joint at stringer 10L. This damage should have been detected visually and in fact, a passenger boarding the aircraft visually saw cracks that were not detected by Aloha mechanics.

Output: Determine acceptable vision standards and procedures for personnel involved in nondestructive inspection and testing (NDI/NDT) and visual inspection of aircraft and aircraft components.

Regulatory Link: The National Transportation Safety Board (NTSB) has cited the failure to visually detect detectable cracks as the probable cause of these accidents.

Appendix III

Human Factors Aviation Maintenance Fiscal Year Project Planning

FY03 Proposed Projects

FY04 Proposed Projects

FY04 Proposed Projects

FY03 Aviation Maintenance
Proposed Projects (~ $850,000)

Task	Performer	Requirement #
Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components	NASA/CAMI/OSU	801
Evaluation of Broadband Applications to Maintenance Safety	NASA/CAMI	864
Using Technology to Support Inspection Training in Corporate, Regional, and GA	Clemson	863
Determine whether language barriers result in maintenance deficiencies	SUNY	862
Amateur built aircraft	CAMI	861
Auditing and Surveillance Maintenance Error Web-Based Tool	TBD	922
An Assessment of Barriers to Implementation of Aviation Safety Action Programs (ASAP) in Maintenance Organizations	TBD	889
General Aviation Alaska Maintenance Accidents	CAMI	918
Effects of fatigue/vigilance/environment on inspectors performing Fluorescent Penetrant and/or Magnetic Particle Inspections	SUNY	920
An Assessment of Computer-Based Maintenance Resource Management (MRM) Training In Diverse Maintenance Environments	CAMI	923

FY04 Aviation Maintenance
Proposed Projects (~ $850,000)

Task	Performer	Requirement #
Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components	NASA/CAMI/OSU	801
Evaluation of Broadband Applications to Maintenance Safety	NASA/CAMI	864
Using Technology to Support Inspection Training in Corporate, Regional, and GA	Clemson	863
Determine whether language barriers result in maintenance deficiencies	SUNY	862
Auditing and Surveillance Maintenance Error Web-Based Tool	TBD	922
An Assessment of Barriers to Implementation of Aviation Safety Action Programs (ASAP) in Maintenance Organizations	TBD	889
General Aviation Alaska Maintenance Accidents	CAMI	918
Effects of fatigue/vigilance/environment on inspectors performing Fluorescent Penetrant and/or Magnetic Particle Inspections	SUNY	920
Sport Pilot Training	TBD	921
An Assessment of Computer-Based Maintenance Resource Management (MRM) Training In Diverse Maintenance Environments	CAMI	923

FY05 Aviation Maintenance
Proposed Projects ($700,000)

Task	**Performer**	**Requirement #**
Using Technology to Support Inspection Training in Corporate, Regional, and GA	Clemson	863
Auditing and Surveillance Maintenance Error Web-Based Tool	TBD	922
An Assessment of Barriers to Implementation of Aviation Safety Action Programs (ASAP) in Maintenance Organizations	TBD	889
Effects of fatigue/vigilance/environment on inspectors performing Fluorescent Penetrant and/or Magnetic Particle Inspections	SUNY	920
Sport Pilot Training	TBD	921
An Assessment of Computer-Based Maintenance Resource Management (MRM) Training In Diverse Maintenance Environments	CAMI	923